

# CEA-Leti Si-PHOTONICS AND SiN-PHOTONICS PROTOTYPING AND LOW VOLUME PRODUCTION

EUROPRACTICE provides Multi-Project-Wafer prototyping and Volume Production services of CEA-Leti Silicon Photonics and Silicon Nitride Photonics.

# **Technology Highlights**

# Why EUROPRACTICE?

- Affordable and easy access to Prototyping and Small Volume Production services for academia and industry.
- MPW (Multi-Project-Wafer) runs for various technologies, including ASICs, Photonics, MEMS and GaN.
- Advanced packaging, system integration solutions and test services.

# Why CEA-Leti?

- Technology research institute that is a pioneer in the field of microand nanotechnologies.
- Multidisciplinary teams delivering solid expertise in architecture and IC design, silicon components and technologies, optics and photonics, systems integration and more.
- Long-term relationship with industrial partners, including global companies, SMEs and start-ups.

#### Silicon Photonics Si-310

The Si-310 technology is based on SOI wafers with a silicon film thickness of 310nm and a Buried OXide (BOX) thickness of  $2\mu$ m. The manufacturing process uses epitaxial germanium to form the photodiodes, six implantation steps to make the modulators, three etching operations to take advantage of different types of waveguide (strip, rib and deep rib), contact salicidation to reduce the modulator access resistances, and two metal levels for optimal routing. The Si-310 technology also enables the integration of a SiN layer above the SOI for enhanced functionalities. Therefore, the designer has a wide range of active and passive devices, which allows to fiberize chips by edge coupling. The Si-310 technology is a complete toolbox featuring state-of-the-art performance for communication, computing and optical sensing.

#### Silicon Photonics Si-220

The Si-220 technology is derived from Si-310. It has a reduced SOI thickness of 220nm for a BOX thickness maintained at  $2\mu$ m and incorporates an annealing step to reduce waveguide surface roughness and minimize propagation losses. To decrease the cycle time, EUROPRACTICE offers only manufacturing of passive devices and the heating resistor. The SiN layer will also be made available in a very near future.

#### Silicon Nitride Photonics Si<sub>3</sub>N<sub>4</sub>-800

Si3N4-800 allows to form waveguides and resonators from an 800nm-thick layer of Si<sub>3</sub>N<sub>4</sub> deposited by Low-Pressure Chemical Vapor Deposition (LPCVD). This technology drastically reduces propagation losses and thermal susceptibility, increases power damage thresholds, and ensures high cross-wafer device performance uniformities. It addresses various applications, including quantum photonics and non-linear optics. It also offers the possibility of producing the active part of sensors, such as LIDARs, thanks to the transparency of Si<sub>3</sub>N<sub>4</sub> over a wide wavelength range.

# **Technology Details**

#### Si-220 & Si-310 library and indicative performances: Passive devices

Component	Specifications	Indicative value	
		1310 nm	1550 nm
Rib waveguide	Loss	< 0.4 dB/cm	< I dB/cm
Strip waveguide	Loss	< 2 dB/cm	< 5 dB/cm
Deep Rib waveguide	Loss	< 3 dB/cm	< 4.5 dB/cm
Rib multimode waveguide	Loss	< 0.2 dB/cm	< 0.2 dB/cm
Transistors	Loss	< 0.03 dB	< 0.03 dB
Fiber grating coupler 1D	Insertion loss	< 2.4 dB	< 2.5 dB
	Central wavelength	1310 nm	1550 nm
	I dB wavelength	27 nm	30 nm
Fiber grating coupler 2 D	Insertion loss	< 5 dB	< 3.5 dB
	Peak wavelength	1310 nm	1550 nm
	I dB bandwidth	25 nm	25 nm
Directional coupler	Loss	< 0.05 dB	< 0.06 dB
Ring filter	Loss	< 0.5 dB	< 0.5 dB
	Extinction ratio	> 15 dB	> 15 dB
	Quality factor	> 10'000	> 10'000
MMI 1x2	Loss	< 0.1 dB	< 0.2 dB
	Output balance	+/- 1%	+/- 2%

# X2.Bák I3.Bim/

2D grating coupler



Highly confined waveguide

### Active devices

Component	Specifications	Indicative value	
		1310 nm	1550 nm
Mach Zehnder modulator (3 mm long)	OE bandwidth @-4V	40 GHz	40 GHz
	Loss junction	< I dB/mm	< 0.8 dB/mm
	VpiLpi @-2V	< 1.5 V.cm	< 2 V.cm
Ring racetrack modulator	OE bandwidth @-2V	> 15 GHz	> 15 GHz
	Insertion loss	< 0.5 dB	< 0.5 dB
	VpiLpi @-2V	< 2.5 V.cm	< 2.5 V.cm
Ge PiN photodiode Longitudinal	EO bandwidth @-IV	> 35 GHz	> 35 GHz
	Responsivity @-1V	> 0.75 A/W	> 0.7 A/W
	Dark current @-IV	< 50 nA	< 55 nA



Germanium photodiode

## Si<sub>3</sub>N<sub>4</sub>-800 library and indicative performances

Component	Specifications	Indicative value for C-band
Strip waveguide	Loss	< 0.3 dB
Fiber grating coupler 1D	Insertion loss	< 12.5 dB
Directional coupler	Insertion loss	< 0.05 dB
MMI 1x2	Insertion loss	< 0.1 dB
Resonator	Average attenuation coefficient	3 dB/m for 1.6 $\mu m$ x 800 nm height
	Intrinsic quality factor	10 7



Arrayed waveguide grating demultiplexer

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